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Rainey

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(54) **SEGMENTAL RETAINING WALL SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/339,132**

(22) Filed: **Jun. 24, 1999**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/049,627, filed on Mar. 27, 1998, now Pat. No. 6,089,793.

(51) **Int. Cl.**[7] **E02D 17/00**; E04C 1/00

(52) **U.S. Cl.** **405/262**; 405/286; 52/286; 52/603; 52/605; 52/607

(58) **Field of Search** 405/262, 284, 405/286; 52/603–605, 607, 283, 284, 286

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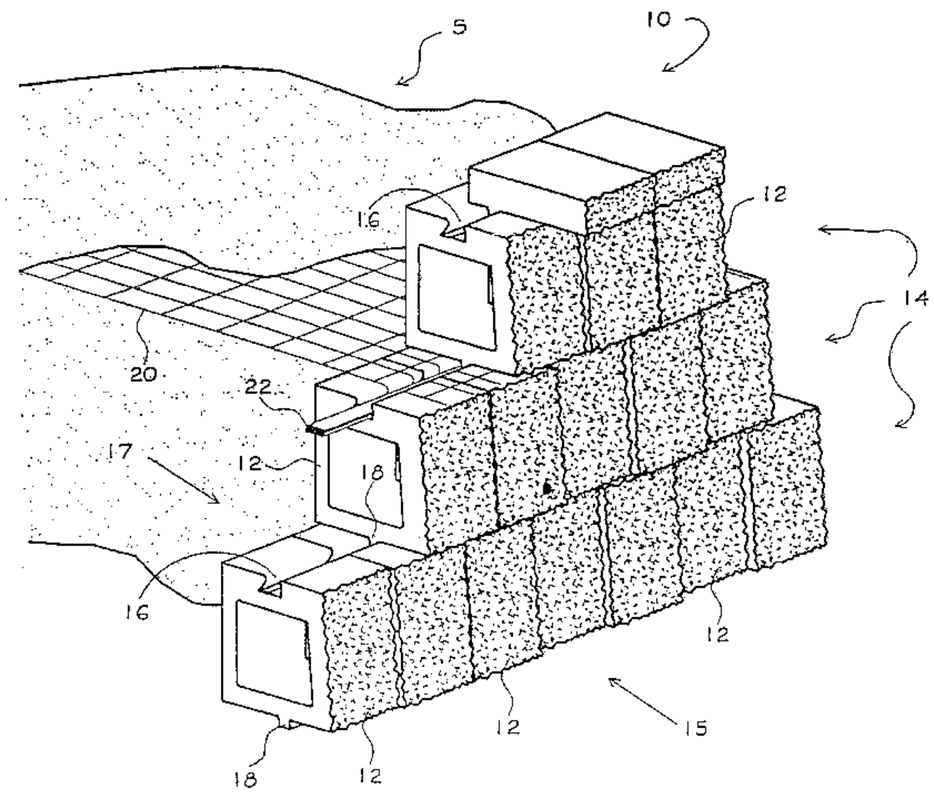
(57) **ABSTRACT**

A segmental retaining wall system comprising a plurality of wall blocks. Each wall block comprises an interior face for forming an interior surface of a segmental retaining wall, an exterior face for forming an exterior surface of the segmental retaining wall, first and second sides that extend from said exterior face to said interior face, a top surface, and a bottom surface. In addition, a plurality of wall blocks include apparatus for retaining a reinforcement member to the segmental retaining wall. In one arrangement, this apparatus comprises a channel that is defined by a front wall, a rear wall, and a channel bottom surface. This channel is provided in one of the faces and surfaces, and includes an inwardly extending shoulder.

22 Claims, 6 Drawing Sheets



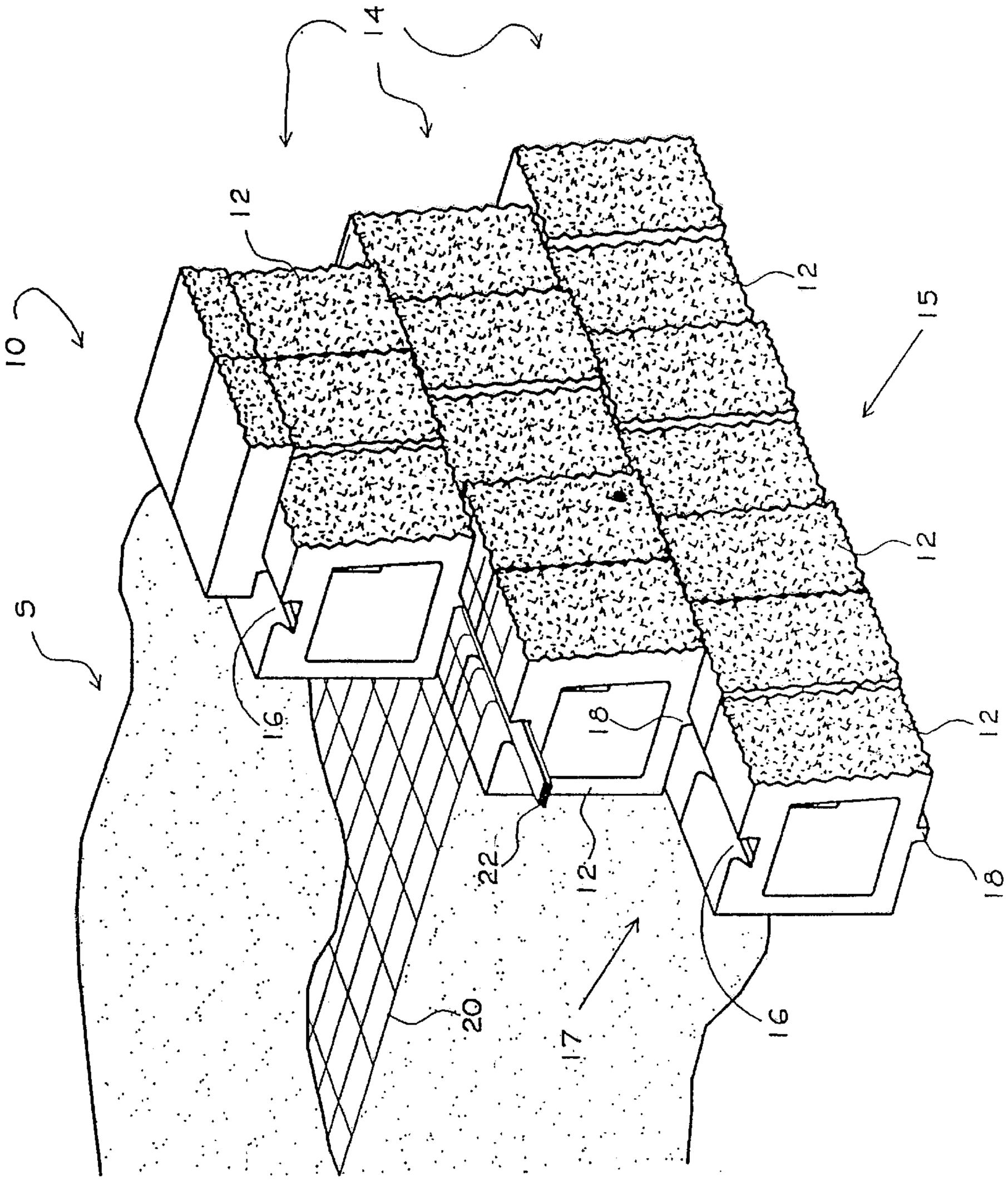


FIG. 1

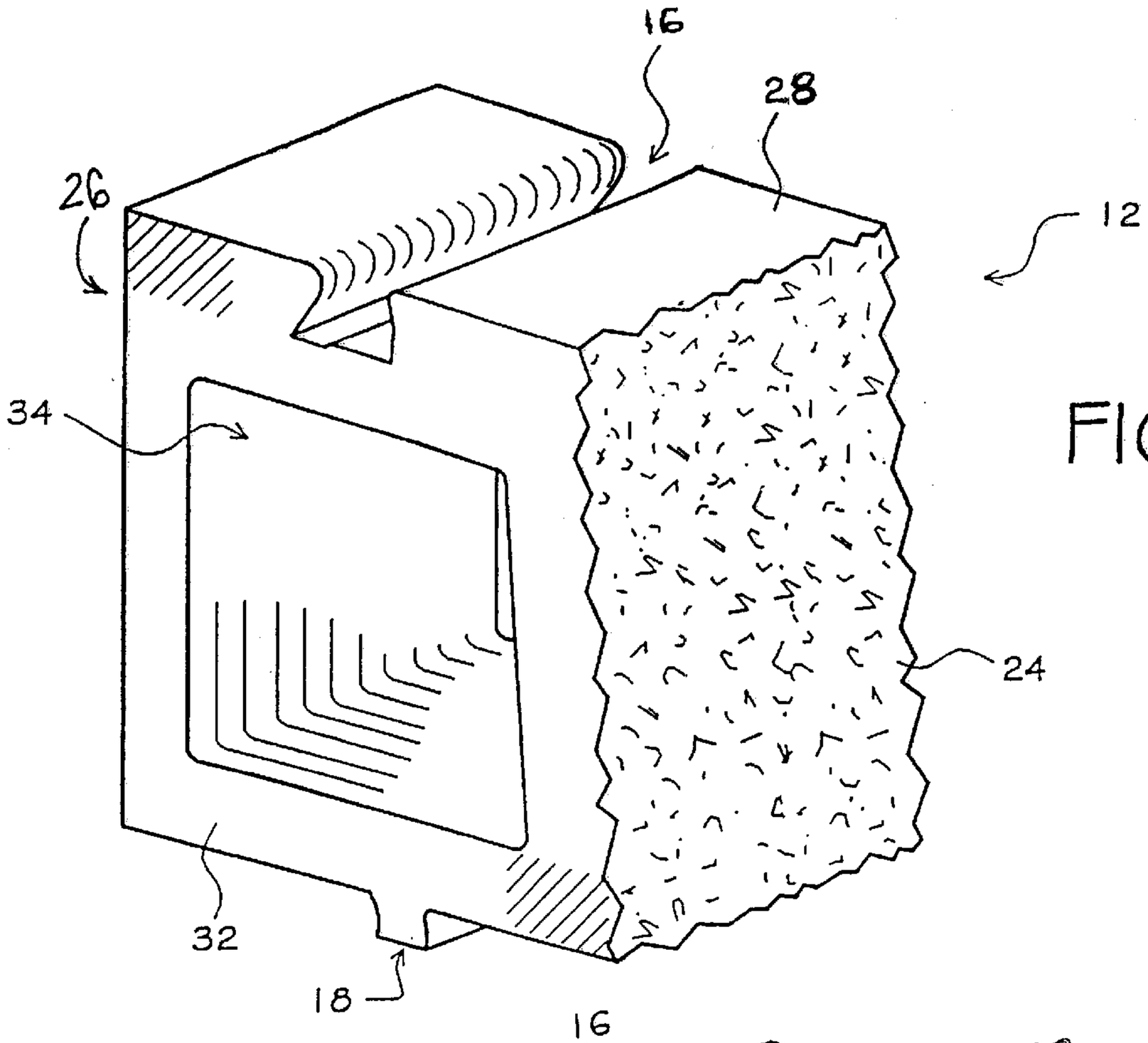


FIG. 2

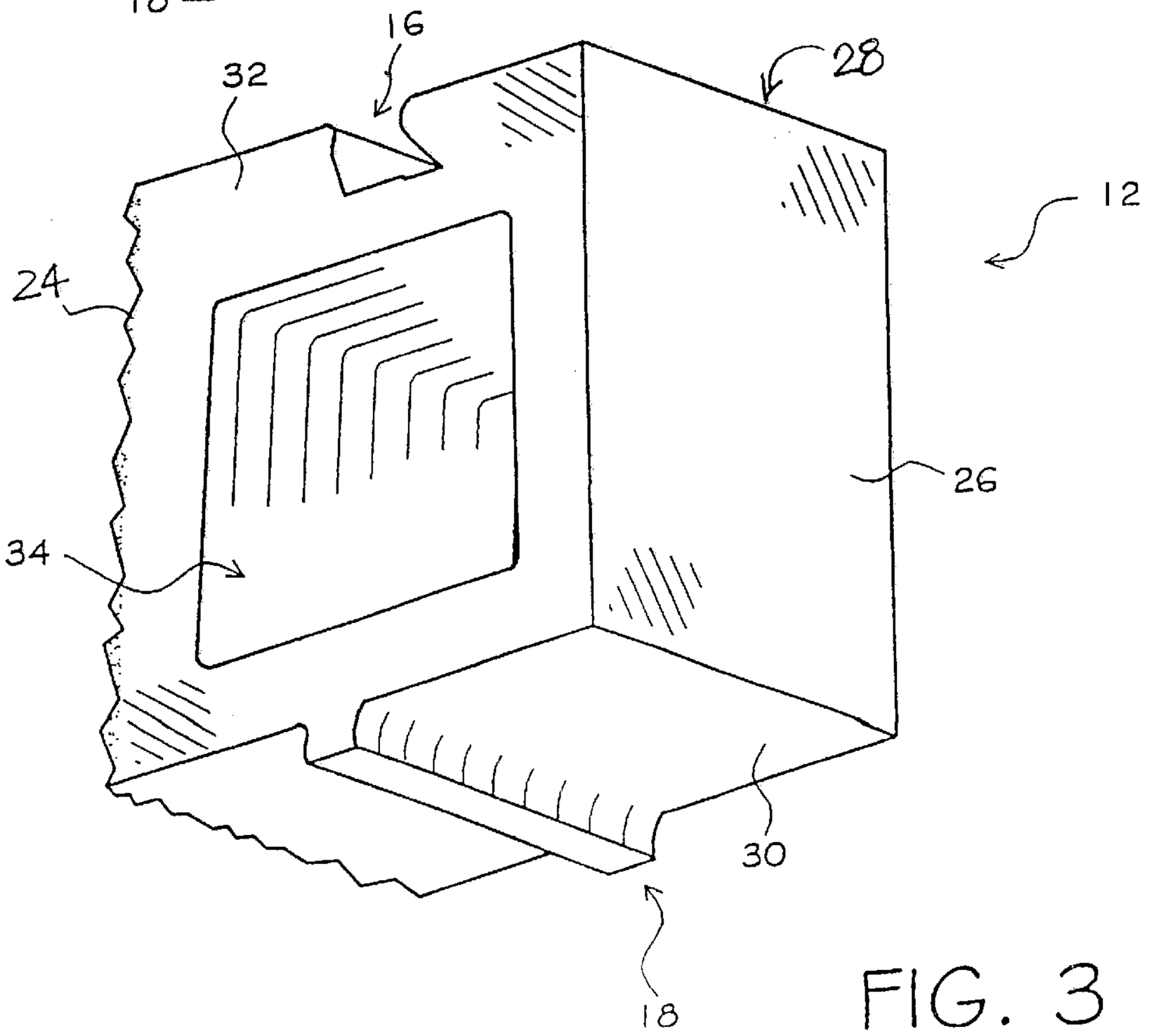


FIG. 3

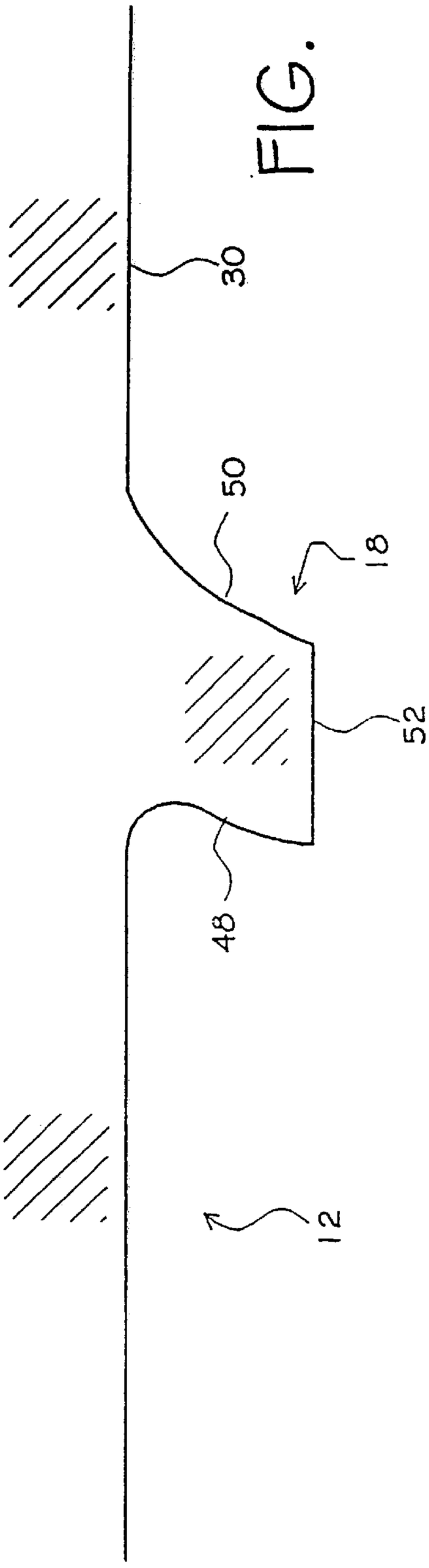


FIG. 5

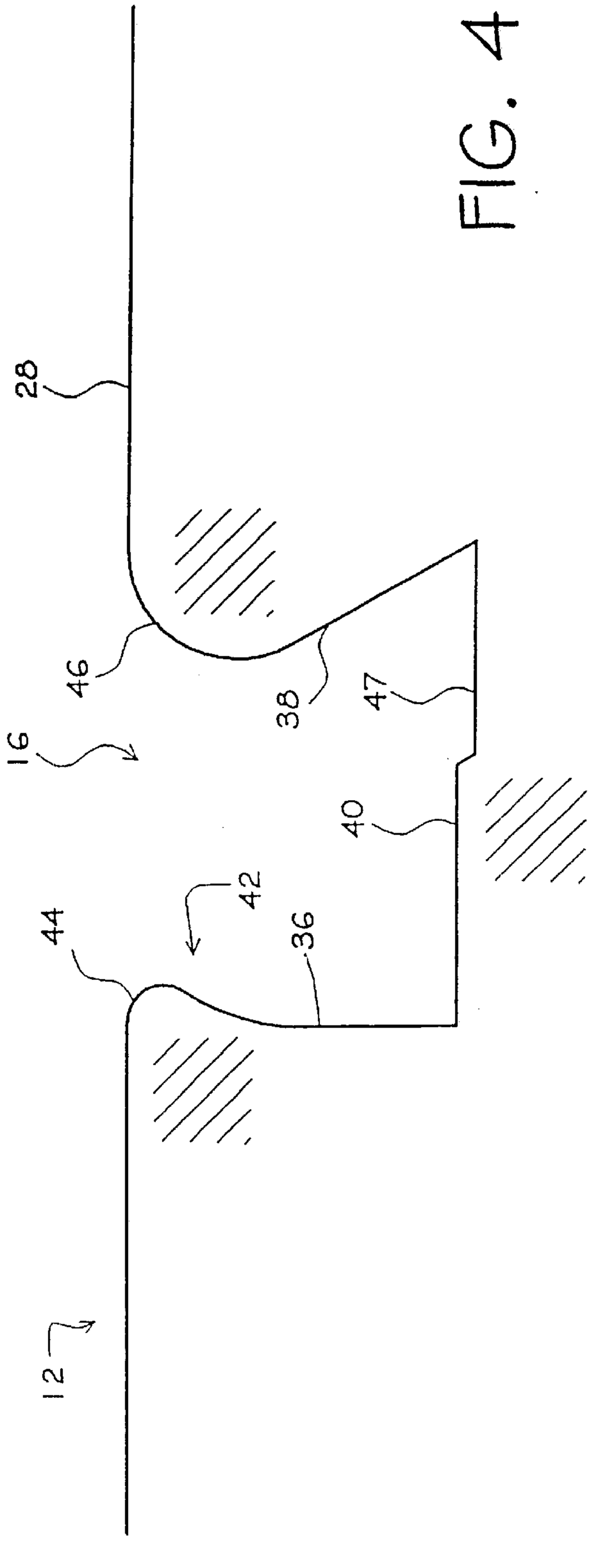


FIG. 4

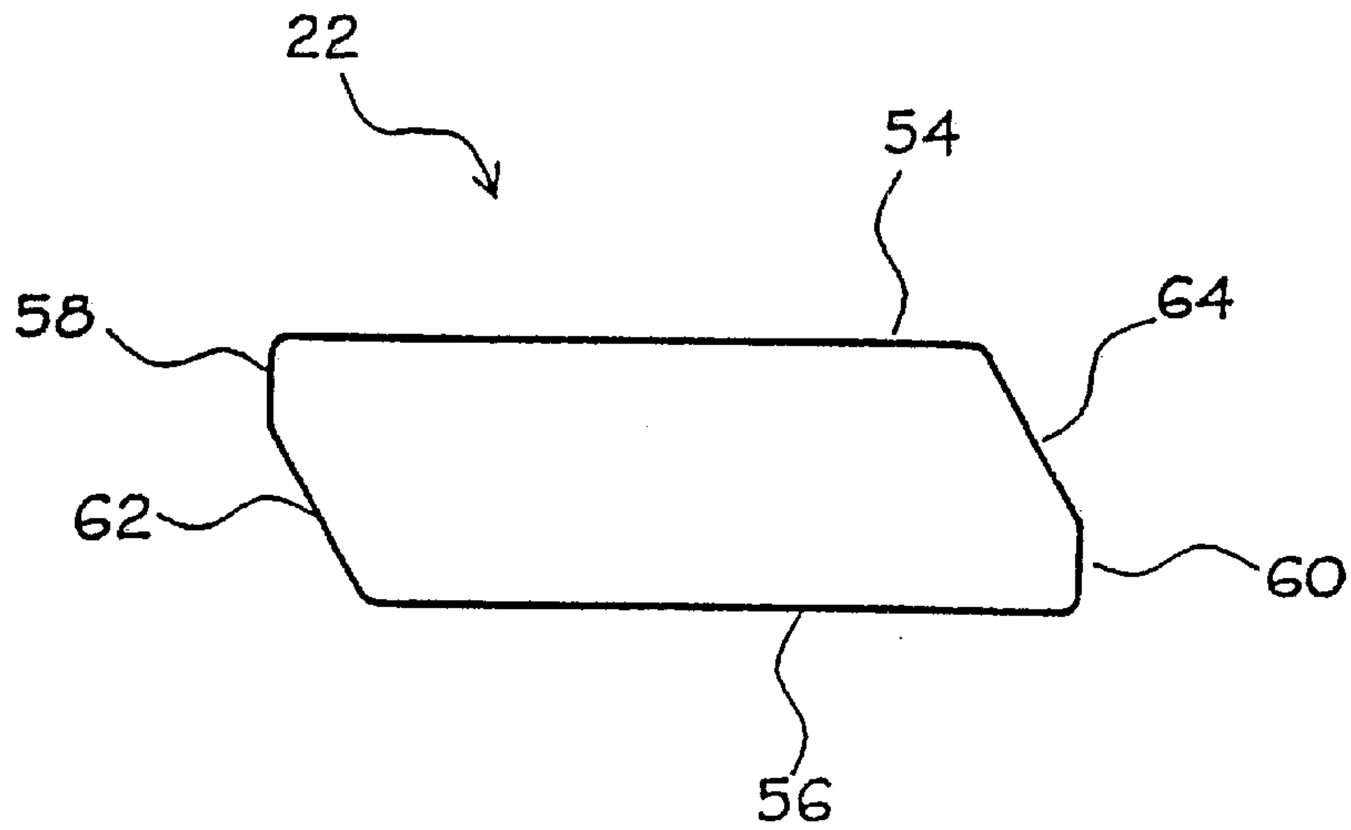


FIG. 6

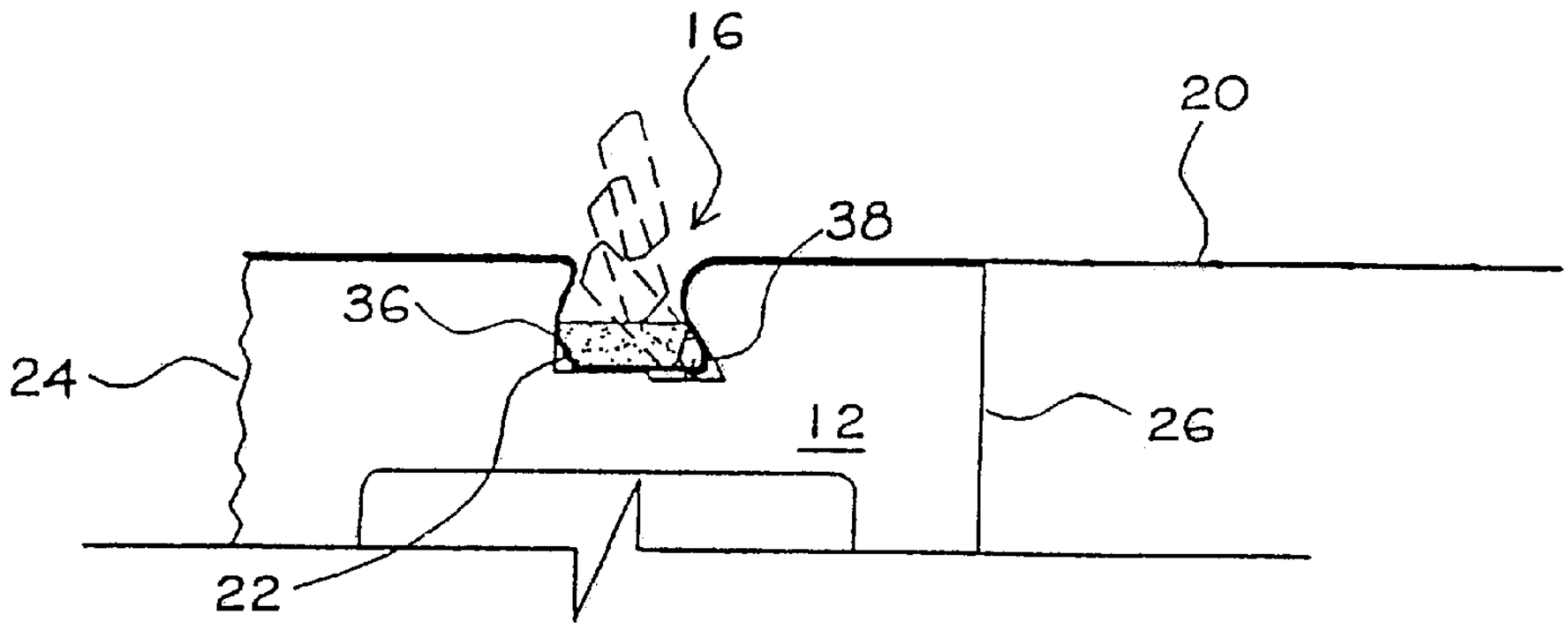


FIG. 7

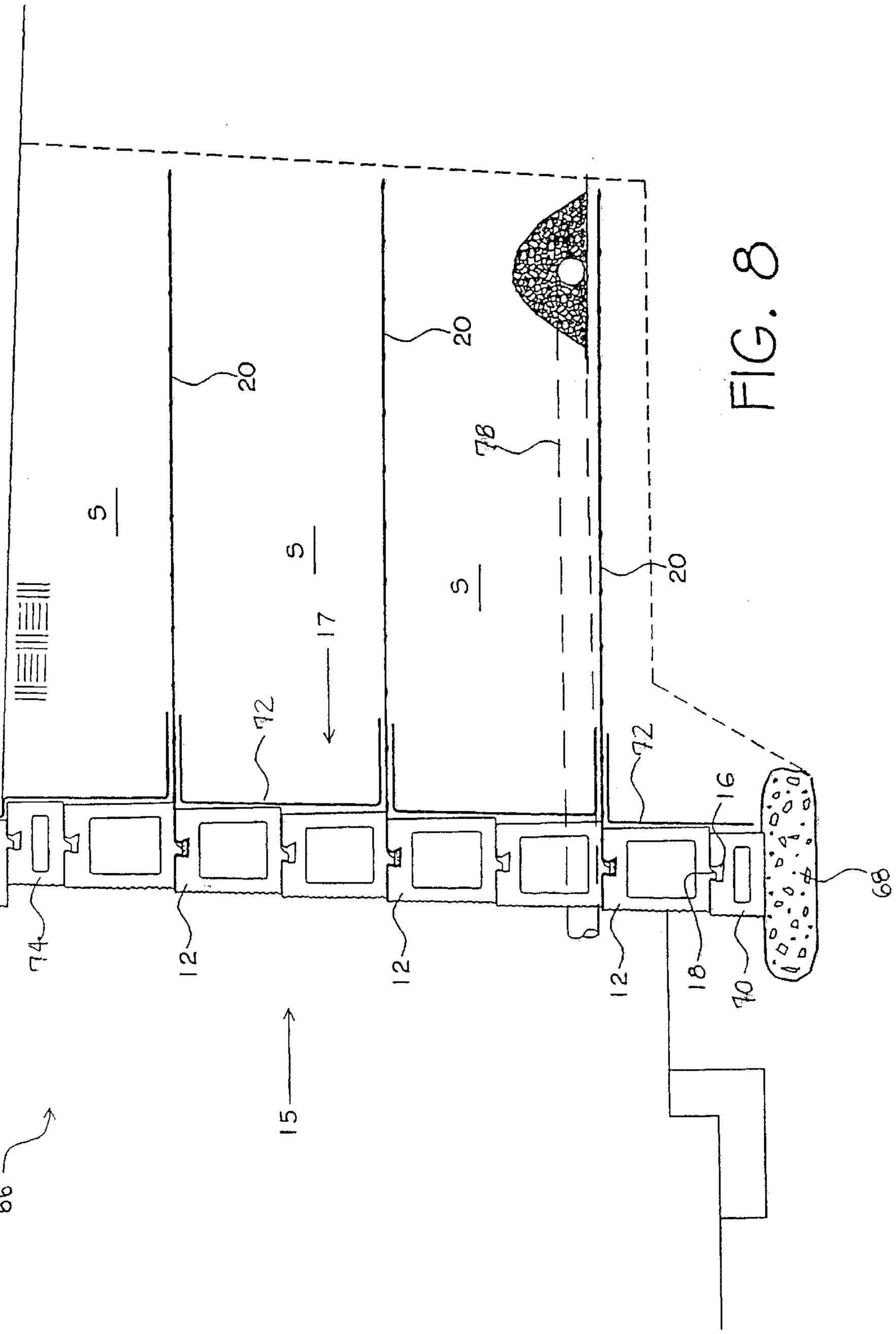


FIG. 8

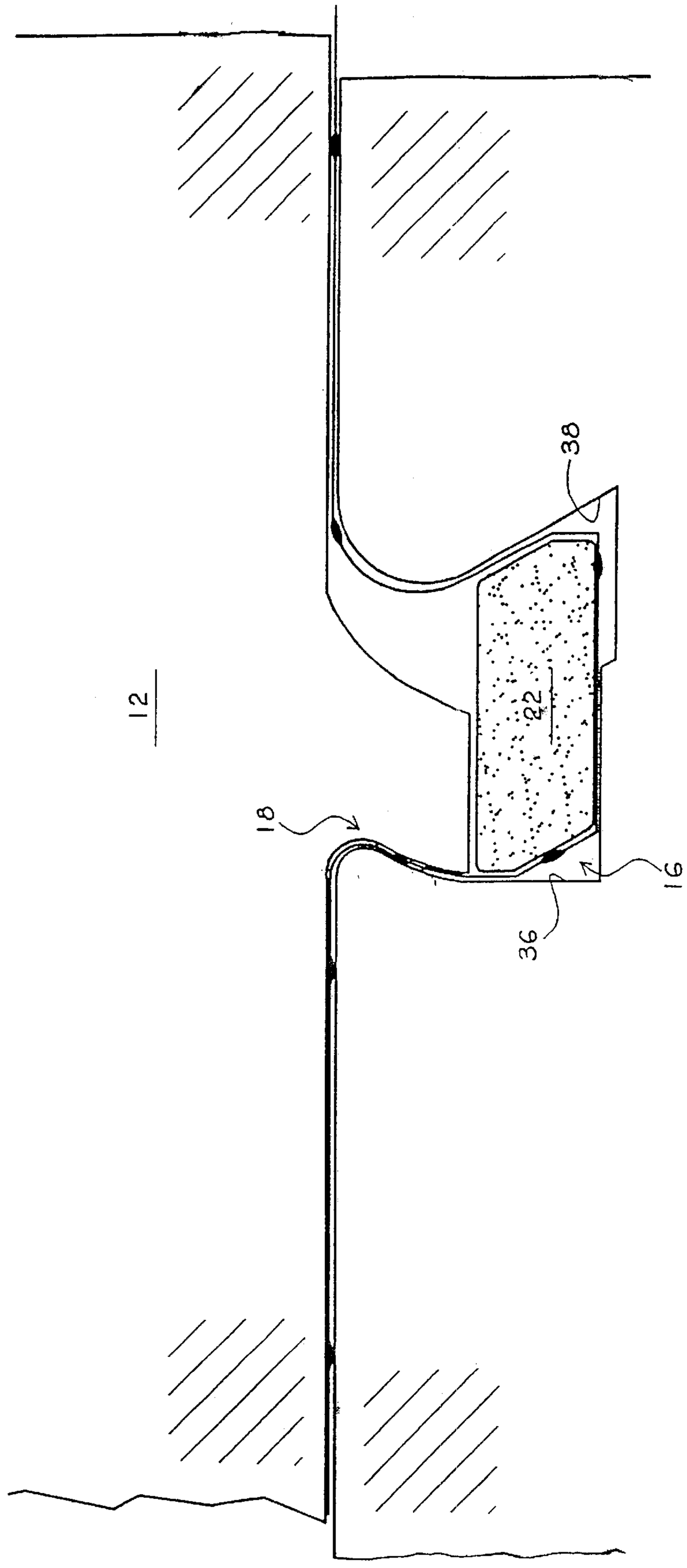


FIG. 9

SEGMENTAL RETAINING WALL SYSTEM

This is a continuation-in-part of U.S. patent application Ser. No. 09/049,627, filed Mar. 27, 1998 now U.S. Pat. No. 6,089,793.

FIELD OF THE INVENTION

The invention relates generally to earth retaining walls. More particularly, the invention relates to a segmental retaining wall system comprising retaining means for attaching reinforcement members to the retaining wall.

BACKGROUND OF THE INVENTION

Segmental retaining walls commonly are used for architectural and site development applications. Such walls are subjected to very high pressures exerted by lateral movements of the soil, temperature and shrinkage effects, and seismic loads. Therefore, the wall is often tied into the backfill soil, typically with tensile reinforcement members. Usually, elongated structures, commonly referred to as geogrids or reinforcement fabrics, are used to provide this reinforcement. Geogrids often are configured in a lattice arrangement and are constructed of a metal or plastic, while reinforcement fabrics are constructed of a woven or nonwoven polymer fibers or plastics. These reinforcement members typically extend rearwardly from the wall and into the soil to stabilize the soil against movement and thereby create a more stable soil mass which results in a more structurally secure retaining wall.

Although several different forms of reinforcement members have been developed, difficulties remain with respect to attachment of the members to retaining walls. In particular, the reinforcement members can shift out of position and be pulled away from the retaining wall due to movement of the soil. This difficulty especially can be problematic in areas of high seismic activity where a poorly secured gravity wall can topple. In response to this problem, several current retaining wall systems have been developed to retain geogrid reinforcement members. In one such system, rake shaped connector bars are positioned transversely in the center of the contact area between adjacent stacked blocks with the prongs of the connector bars extending through elongated apertures provided in the geogrid to retain it in place. Despite adequately holding the geogrid in position under normal conditions, this system of attachment provides a substantial drawback. Specifically, the geogrids of this system only extend along the back halves of the contact areas between the blocks. Although the geogrids are relatively thin, this partial insertion of the geogrids can cause the retaining wall to bow outwardly due to the aggregate thickness of the geogrids. As can be appreciated, this outward bowing can be substantial with tall retaining walls that require a multiplicity of geogrids. Aside from creating the impression of instability, this condition increases the likelihood of wall failure, particularly in response to seismic activity.

From the above, it can be appreciated that it would be desirable to have a mechanically stable wall system having secure retaining means for maintaining connection of reinforcement members to the retaining wall.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a segmental retaining wall system. This system comprises a plurality of wall blocks. Each wall block comprise an

interior face for forming an interior surface of a segmental retaining wall, an exterior face for forming an exterior surface of the segmental retaining wall, first and second sides that extend from said exterior face to said interior face, a top surface, and a bottom surface. In addition, the wall block includes retaining means for retaining a reinforcement member to the segmental retaining wall. In one arrangement, these retaining means comprises a channel that is defined by a front wall, a rear wall, and a channel bottom surface. This channel is provided in one of the faces and surfaces of the block, and preferably includes at least one inwardly extending shoulder.

The objects, features, and advantages of this invention will become apparent upon reading the following specification, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a retaining wall formed in accordance with the present invention.

FIG. **2** is a perspective front view of a wall block used in the wall shown in FIG. **1**.

FIG. **3** is a perspective rear view of the wall block shown in FIG. **2**.

FIG. **4** is a detail view of a channel provided in a top surface of a wall block.

FIG. **5** is a detail view of a flange provided on a bottom surface of a wall block.

FIG. **6** is a side view of a reinforcement member retaining bar.

FIG. **7** is a partial side view of a wall block depicting insertion of the retaining bar shown in FIG. **6** over a reinforcement member within a channel of the wall block.

FIG. **8** is a cross-sectional side view of a retaining wall constructed in accordance with the present invention.

FIG. **9** is a detail view showing the retention of a reinforcement member between adjacent stacked wall blocks.

DETAILED DESCRIPTION

Referring now in more detail to the drawings, in which like numerals indicate corresponding parts throughout the several views, FIG. **1** illustrates the general concept of a segmental gravity retaining wall **10** constructed in accordance with the present invention. As depicted in this figure, the retaining wall **10** comprises a plurality of wall blocks **12** that are stacked atop each other in ascending courses **14**. When stacked in this manner, the wall blocks **12** together form an exterior or decorative surface **15** which faces outwardly away from the soil, and an interior surface **17** which faces inwardly toward the soil.

Generally speaking, the wall blocks **12** are substantially identical in size and shape for ease of block fabrication and wall construction. Accordingly, each block **12** typically is configured so as to mate with vertically adjacent blocks when the blocks are stacked atop one another to form the retaining wall **10**. Referring to FIGS. **2** and **3**, each wall block **12** comprises an exterior face **24**, an opposed interior face **26**, a top surface **28**, a bottom surface **30**, and two opposed sides **32**. Because the exterior faces **24** of the blocks **12** form the exterior surface **15** of the retaining wall **10**, the exterior faces typically are provided with an ornamental texture or facing to create a visually pleasing facade. Also, the exterior face **24** of each wall block **12** is preferably

sloped inwardly from the bottom surface **30** to the top surface **28** in an incline ratio of approximately 30 to 1. This inward slope of each block exterior surface **15** creates an aggregate inward slope effect over the entire retaining wall **10** which counteracts the outward leaning impression commonly created by such walls when viewed by the observer. Contrary to the exterior faces **24**, the interior faces **26** of the wall blocks **12** normally are configured in an upright or vertical orientation and, therefore, form an upright interior surface **17** of the retaining wall **10**.

The top and bottom surfaces **28** and **30** of each block **12** typically are parallel to each other so that, when stacked on top of one another, an upright wall **10** is formed. Similarly, the opposed sides **32** typically are parallel to each other. However, the opposed sides **32** can be inwardly or outwardly tapered from the exterior face **24** of the block **12** to the interior face **26** of the block to form curved walls of nearly any shape. Preferably, the wall blocks **12** further include interior openings **34** which reduce the amount of concrete or other materials needed to fabricate the blocks and reduce the weight of the blocks to simplify wall construction. Although depicted in the figures as being arranged in a horizontal orientation, these openings could be arranged in a vertical orientation, if desired.

As mentioned above, the wall blocks **12** typically comprise retaining means for attaching reinforcement members (e.g., geogrid) to the retaining wall **10**. These retaining means include a channel **16**. Typically, each block **12** has a channel **16** provided in its top surface **28**, although alternative placement is feasible. By way of example, the channel **16** alternatively could be provided in the bottom surface **30** or the interior face **26** of the wall block **12**. When provided in the interior face **26** of the block **12**, the channel **16** can be arranged either horizontally or vertically therein, although horizontal placement is preferred. When the channel **16** is provided in the top surface **28**, however, the channel normally extends transversely across the block **12** from one side **32** of the block to the other, usually parallel to the exterior surface **15** of the block **12**. As illustrated in FIG. **4**, the channel **16** is defined by a front wall **36**, a rear wall **38**, and a channel bottom surface **40**. The front wall **36** can include a shoulder **42** that extends inwardly toward the interior face **26** of the wall block **12**. In a preferred embodiment, the shoulder **42** is arranged as a curved lip such that the channel comprises a first substantially arcuate edge **44**.

Positioned opposite the front wall **36**, the rear wall **38** of the channel **16** preferably similarly includes an inwardly extending shoulder **45**. The rear wall shoulder **45** preferably is arranged as a curved lip so as to form a second substantially arcuate edge **46** of the channel **16**. Although the shoulders **42**, **45** have been described herein as being arranged as curved lips, it will be apparent from the present disclosure that these shoulders alternatively could be arranged as inwardly extending flanges or other such protrusions. Furthermore, depending upon the particular implements used to retain the reinforcement members, the placement of the channel **16**, and the degree of block-to-block locking desired, the walls **36**, **38** can be formed without such shoulders **42**, **45** to simplify block construction. For example, if the channel **16** is not used to facilitate block-to-block locking, the front wall **36** can be substantially planar in shape in that it does not serve the retaining function that the rear wall **38** serves (see FIG. **9**).

Where block-to-block locking is desired, the front wall **36** typically includes a shoulder **42** that is adapted to receive a flange **18** that extends from the block **12**. In a preferred embodiment, the flange **18** is provided on the bottom surface **30** of the block **12** and, like the channel **16**, extends transversely from one side **32** of the block to the other side **32**. As is illustrated in FIG. **5**, the flange **18** is defined by a front surface **48**, a rear surface **50**, and a bottom surface **52**. Both the front surface **48** and the rear surface **50** extend toward the exterior face **24** of the wall block **12** such that the entire flange **18** extends towards the exterior face **24** of the block. To provide for the interlocking between vertically adjacent wall blocks **12**, the blocks can be placed on top of lower wall blocks **12** such that the flanges **18** extend into the channels **16**. Once so situated, the upper wall blocks can be urged forwardly along the lower blocks so that the front surfaces **48** of the flanges **18** abut the front walls **36** of the channels **16**. This abutment prevents the block from leaning forward or toppling. As is known in the art, alternative locking means can be used such as pin and cavity, protrusion and cavity, mating/aligning systems. Example systems include these of U.S. Pat. Nos. 4,914,876, 5,257,880, 5,607,262, and 5,827,015.

The retaining means of the disclosed system typically further include a reinforcement member retaining bar **22**, shown most clearly in FIG. **6**. As indicated in this figure, the retaining bar **22** specifically is sized and configured to fit within the channel **16**. In a preferred arrangement, the retaining bar **22** has a plurality of different surfaces: a top surface **54**, a bottom surface **56**, a first upright surface **58**, a second upright surface **60**, a first oblique surface **62**, and a second oblique surface **64**. Normally, the top surface **54** and the bottom surface **56** are parallel to each other as are the first oblique surface **62** and the second oblique surface **64**. Similarly, the first upright surface **58** and the second upright surface **60** typically are parallel to each other such that the first upright surface extends perpendicularly from the top surface **54** and the second upright surface extends perpendicularly from the bottom surface **56**. Configured in this manner, the retaining bar **22** can be positioned on top of a reinforcement member **20** in the channels **16** by inserting the retaining bar into the channels with the second upright surface **60** forward, and twisting the bar downwardly into place as depicted in FIG. **7**. In that the bar **22** is designed to fit closely between the front and rear walls **36** and **38** of the channels **16** when in place, a longitudinal notch **46** is provided in the channel **16** to accommodate the second upright surface **60** during the twisting and downward insertion of the bar.

Once correctly inserted within the channel **16**, the first upright surface **58** and the second oblique surface **64** of the retaining bar **22** hold the reinforcement member **20** against the front and rear walls **36** and **38** of the channel, respectively, as shown in FIG. **7**. In embodiments in which the flange **18** is not provided, the channel **16** can have a relatively shallow depth dimension. The retaining bar **22** prevents the reinforcement member **20** from being pulled out from the retaining wall **10**. Specifically, when a tensile force is applied to the reinforcement member **20** from the soil side of the retaining wall **10**, the retaining bar **22** is rotated within the channel **16** to cause the reinforcement member to be clamped by member **20** to the sides of the channel, locking the reinforcement member in place. In that the amount of pressure that is applied on the retaining bar **22** is not large, the retaining bar can be constructed of a polymeric material such as nylon 6,6 or high density polyethylene. Use of such a polymeric material provides the additional advantage of providing for a lightweight, inert retaining bar.

The system of the present invention can be used to construct any number of different configurations of segmen-

tal retaining walls. FIG. **8** illustrates one example of such a retaining wall **66**. To construct such a wall **66**, a leveling pad **68** is laid to provide a foundation upon which to build the wall. Typically, this leveling pad **68** comprises a layer of compacted, crushed stone that is embedded under the soil to protect the wall foundation. Once the leveling pad **68** is laid and compacted, a plurality of starting blocks **70** are aligned along the length of the pad. Each of the starting blocks **70** is provided with a channel in its top surface. However, since there are no lower courses with which to engage, the starter blocks **70** are not provided with flanges, or existing flanges on the block can be broken off with a hammer. Additionally, special starting blocks (if used) can be relatively short in height, typically being approximately half as tall as the wall blocks. Although such starting blocks **70** typically are used in the starting course of the retaining wall, it is to be noted that the standard wall blocks **12** could be used to form this course, if desired.

After the starting course has been formed with either the starting blocks **70** or wall blocks **12**, the next course of blocks can be laid. The wall blocks **12** are placed on top of the blocks of the starting course with the flanges **18**, if provided, extending into the channels **16** of the lower blocks. As can be appreciated from FIG. **8**, and with reference to FIGS. **4** and **5**, the front surfaces **48** of the flanges mate with the front wall shoulders **42** of the channels **16** such that each flange **18** extends underneath the shoulders. This mating relationship holds the wall block **12** in place atop the lower blocks and prevents the wall block from tipping forward, thereby providing integral locking means for the block.

Once the first wall course has been formed atop the starting course, backfill soil, S, can be placed behind the blocks **12**. Typically, a non-woven filter fabric **72** is provided between the wall **66** and the backfill soils to prevent the introduction of particulate matter between the courses of blocks due to water migration within the soil. Alternatively, a layer of gravel aggregate can be provided between the wall and the soil to serve the same function. Additional ascending courses thereafter are laid in the manner described above. Although alternative configurations are possible, a reinforcement member **20** typically is laid between every other course of blocks **12** as indicated in FIG. **8**. It will be appreciated, however, that greater or fewer reinforcement members **20** can be provided depending upon the particular reinforcement needs of the construction site. Preferably, these reinforcement members **20** are composed of a flexible polymeric fabric. As described above, the reinforcement members **20** are positioned so that they extend from the exterior surface **15** of the retaining wall, into the channel **16**, and past the exterior surface **17** of the retaining wall to extend into the soil. As shown most clearly in FIG. **9**, a reinforcement member retaining bar **22** is placed on top of the reinforcement member **20** in the channel **16**. When the next course of blocks **12** is laid on top of the lower course, the flange **18** of the upper blocks extends into the channel **16** adjacent the retaining bar.

Construction of the retaining wall **66** continues in this manner until the desired height is attained. As indicated in FIG. **8**, the inward slope of the wall blocks **12** creates a net inward slope of the retaining wall. Additionally, the configuration the blocks **12** creates an aesthetically pleasing stepped appearance for the exterior surface of the wall **66**. Where the full height of a wall block **12** is unnecessary or not desired, short wall blocks **74** can be used to form the top course. Typically, these short wall blocks **74** are approximately half the height of the standard wall blocks **12**. Once the retaining wall **66** has been raised to the required height, cap blocks **76** can be used to complete the wall. As shown in FIG. **8**, these cap blocks **76** can be provided with a flange **18**, but do not have an upper channel in that further construction will not be conducted. Normally, the cap blocks **76** are fixed in position with concrete adhesive and the top surface of the cap blocks are provided with an ornamental pattern similar to the exterior faces of the blocks. The cap block **76** is designed to extend out over the lower block to provide a lip for aesthetics. Additionally, a subsurface collector drain **78** can be provided within the backfill soil to remove excess water collected therein.

While preferred embodiments of the invention have been disclosed in detail in the foregoing description and drawings, it will be understood by those skilled in the art that variations and modifications thereof can be made without departing from the spirit and scope of the invention as set forth in the following claims. For instance, although particular block configurations have been identified herein, persons having ordinary skill in the art will appreciate that the concepts disclosed herein, in particular the retaining means described herein, are applicable to prior and future wall block designs.

What is claimed is:

1. A wall block for use in a segmental retaining wall system, said wall block comprising:

an interior face for forming an interior surface of a segmental retaining wall;

an exterior face for forming an exterior surface of the segmental retaining wall;

first and second sides that extend from said exterior face to said interior face;

a top surface and a bottom surface; and

a channel defined by a front wall, a rear wall, and a channel bottom surface and extending across one of said faces and surfaces, said rear wall including an inwardly extending shoulder.

2. The wall block of claim **1**, wherein said channel is formed in said top surface of said wall block.

3. The wall block of claim **2**, wherein said channel extends transversely across said top surface from said first side to said second side of said wall block.

4. The wall block of claim **1**, wherein said rear wall shoulder is formed as a curved lip.

5. The wall block of claim **1**, wherein said channel is adapted to receive a reinforcement member retaining bar.

6. The wall block of claim **1**, wherein said front wall of said channel includes an inwardly extending shoulder.

7. The wall block of claim **6**, wherein said front wall shoulder is formed as a curved lip.

8. The wall block of claim **1**, further comprising a flange that is sized and configured so as to mate with a channel of another of said blocks.

9. The wall block of claim **8**, wherein said flange is provided on said bottom surface of said wall block.

10. The wall block of claim **1**, wherein said wall block is formed of a concrete material.

11. A segmental retaining wall system comprising:

a wall block including:

an interior face for forming an interior surface of a segmental retaining wall;

an exterior face for forming an exterior surface of the segmental retaining wall;

first and second sides that extend from said exterior face to said interior face;

a top surface and a bottom surface; and

retaining means for retaining a reinforcement member to the wall block, said retaining means including a channel defined by a front wall, a rear wall, and a channel bottom surface and extending across one of said wall block faces and surfaces, at least one of said front wall and rear wall having an inwardly extending shoulder associated therewith.

12. The system of claim **11**, wherein said retaining means comprises a retaining bar that is sized and configured to fit within said channel.

13. The system of claim **12**, wherein said channel extends transversely across said top surface from said first side to said second side of said wall block.

14. The system of claim **13**, wherein said inwardly extending shoulder is associated with said rear wall of said channel.

15. The system of claim **14**, wherein said rear wall shoulder is formed as a curved lip.

16. The system of claim **13** wherein the inwardly extending shoulder is associated with said front wall of said channel.

17. The system of claims **11**, **14**, or **16**, wherein said inwardly extending shoulder is integrally formed with its associated channel wall.

18. The system of claim **13** wherein an inwardly extending shoulder is associated with said front wall of said channel and an inwardly extending shoulder is associated with said rear wall of said channel.

19. The system of claim **18** wherein each inwardly extending shoulder is integrally formed with its associated channel wall.

20. The system of claim **11**, wherein said wall block is formed of a concrete material.

21. A method for forming a segmental retaining wall, said method comprising the steps of:

stacking a plurality of wall blocks in aligned courses, a plurality of said wall blocks having a channel formed therein, the channel including at least one inwardly extending shoulder; and

securing at least one reinforcement member to the wall with a retaining bar that overlaps the reinforcement member within the channel;

wherein the retaining bar in cooperation with the channel secures the reinforcement member to the wall when tensile forces are imposed upon the reinforcement member.

22. The method of claim **21**, wherein the at least one inwardly extending shoulder is formed with a curved lip.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

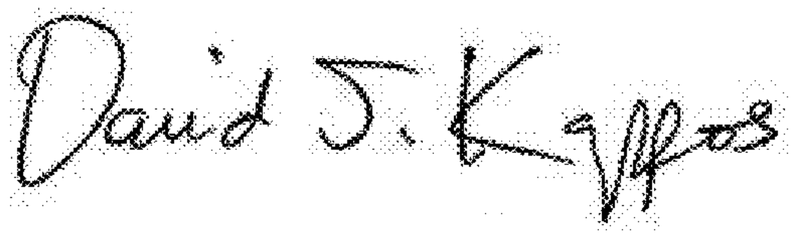
CERTIFICATE OF CORRECTION

PATENT NO. : 6,416,257 B1
APPLICATION NO. : 09/339132
DATED : July 9, 2002
INVENTOR(S) : Rainey

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1, lines 3-5, the sentence "This is a continuation-in-part of U.S. patent application Ser. No. 09/049,627, filed Mar. 27, 1998 now U.S. Pat. No. 6,089,793." should be deleted.

Signed and Sealed this
Thirteenth Day of September, 2011



David J. Kappos
Director of the United States Patent and Trademark Office